

from the **California Academy of Sciences**

Live

The King of Camouflage.
Meet the leafy seadragon (no, it's not a piece of seaweed).

Look Inside:

A reef is growing

Ants are marching

Urchins are "stalking"

Opening Day approaches



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SCIENCES

California Academy of Sciences

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Welcome to your first issue of *LIVE from the California Academy of Sciences*, the Academy's newly redesigned member publication. Based on your feedback, we've added more information about

the exciting science that takes place behind the scenes at the Academy every day. We have also created profiles for Academy animals, research specimens, and people. Read on to learn how hummingbirds chirp, why sea lilies shed their stalks, and how ants can help save the planet.

While Academy scientists continue to explore and study the natural world, Academy educators and exhibit designers are busy incorporating their latest findings into the museum's innovative new exhibits in Golden Gate Park. New climate change research is being added to the *Altered State: Climate Change in California* exhibit (along with a 4,000-pound blue whale skeleton and a towering *T. rex*). And new species discovered in Madagascar are making their way into the *Islands of Evolution* exhibit. We look forward to sharing these exhibits—and much more—with you when the new Academy opens in September.

Greg Farrington
Executive Director

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On the Cover



Leafy seadragons will soon take up residence in the new Academy's *Water Planet* exhibit. Related to seahorses, these slow-moving fishes will share a tank with their slightly less ornamental relatives—weedy seadragons. Learn more in the *Creature Closeup* feature on page 4. Photo: Norbert Wu

On the Back

An elderly penguin gets a new lease on life with the help of a custom-made wetsuit.



Where in the World

Native to waters off the southern and eastern coasts of Australia, leafy seadragons are most frequently found in calm, cold water at depths of up to 80 feet. They favor seaweed beds and seagrass meadows, where they blend most seamlessly into their surroundings.



Buoyancy Control

Like SCUBA divers, seadragons control their vertical movement by adjusting the amount of air in their swim bladders. These organs are very fragile, so the animals cannot cope with sudden changes in water pressure or depth. Water turbulence during heavy storms can prove fatal, causing the swim bladder to rupture.

Life Cycle

Leafy seadragons can live for seven to ten years in the wild and grow to lengths of up to 14 inches. At about two years of age, they reach sexual maturity and find a mate for the first time. Females delegate pregnancy duties to the males, who carry the fertilized eggs on a spongy patch beneath their tails. After six to eight weeks, the tiny offspring begin to hatch, emerging tail-first. They begin swimming just a few hours after birth.

Body Armor

Rather than scales like most fish, seadragons are protected by a series of bony plates. Long, sharp spines protrude from each plate, providing an additional layer of defense.



Leafy Seadragon

You need especially good eyes to spot this spectacular creature in the wild. Sporting leaf-like appendages all over its body, the aptly-named leafy seadragon (*Phycodurus eques*) is virtually indistinguishable from the kelp beds in which it hides. A remarkable product of natural selection, it goes undetected by predators and prey alike as it drifts back and forth with the currents, looking for all the world like a piece of floating seaweed. The flutter of tiny fins and the occasional swivel of an eye are the only clues to its true identity.

Closely related to seahorses, seadragons have long, tubular snouts, which they use like straws to suck up unsuspecting prey. Only the smallest crustaceans can fit through their slender, toothless mouths, so they make up for size with quantity. A single seadragon can slurp down thousands of tiny shrimp each day.

Usually solitary, seadragons congregate each winter to find a mate. Like seahorse males, dragon dads bear the brunt of the parenting responsibilities. However, while seahorse fathers carry fertilized eggs in a pouch on their bellies, male seadragons use a spongy patch underneath their tails, incubating up to 300 eggs at a time.

Because of habitat destruction, pollution, and poaching, seadragon numbers are declining in the wild. They are now fully protected under Australia's state and federal laws. The government allows just one pregnant male to be collected each year—the captive-bred hatchlings are then sent overseas for education and research programs. See a few of these hatchlings for yourself when the new Academy opens on September 27. They'll be on display in the aquarium's Water Planet exhibit.

Anna's Hummingbird

The colorful Anna's Hummingbird (*Calypte anna*) is the most common hummingbird in the Bay Area. This individual was collected in Marin County in 1894. Its relatives are now frequently seen visiting the Academy's living roof, which is planted with one of their favorite sources of nectar—the purple, tubular flowers of the self heal plant.

Anna's Hummingbird took the spotlight earlier this year, when research revealed that it uses a rare method of sound production. During display dives, a male hummingbird climbs 100 feet in the air, then swoops downward in a J-shaped curve. At the bottom of its dive, it emits a brief chirp equivalent to the highest note on a piano, four octaves above middle C. In 1979, a former Academy curator, Luis Baptista, compared sound graphs from the bird's vocalizations and dive chirps, and suggested that because of their similarity, the latter was also produced vocally.

However, Christopher Clark and Teresa Feo of UC Berkeley recently used field recordings of wild birds and wind tunnel tests on individual feathers to demonstrate that it is, in fact, the tail feathers that are responsible for the chirp. When the hummingbird reaches the bottom of its dive, it flares its tail feathers for 0.06 seconds. The airflow over the outermost feathers causes them to vibrate and produce sound, much like a flag fluttering audibly in the wind.

The recent research serves as a reminder that science is a dynamic process, with hypotheses continually tested and long-held notions sometimes challenged. The Academy's specimen collections will allow scientists to continue formulating and testing hypotheses about the biodiversity in the Bay Area and around the world for years to come.



Where in the World

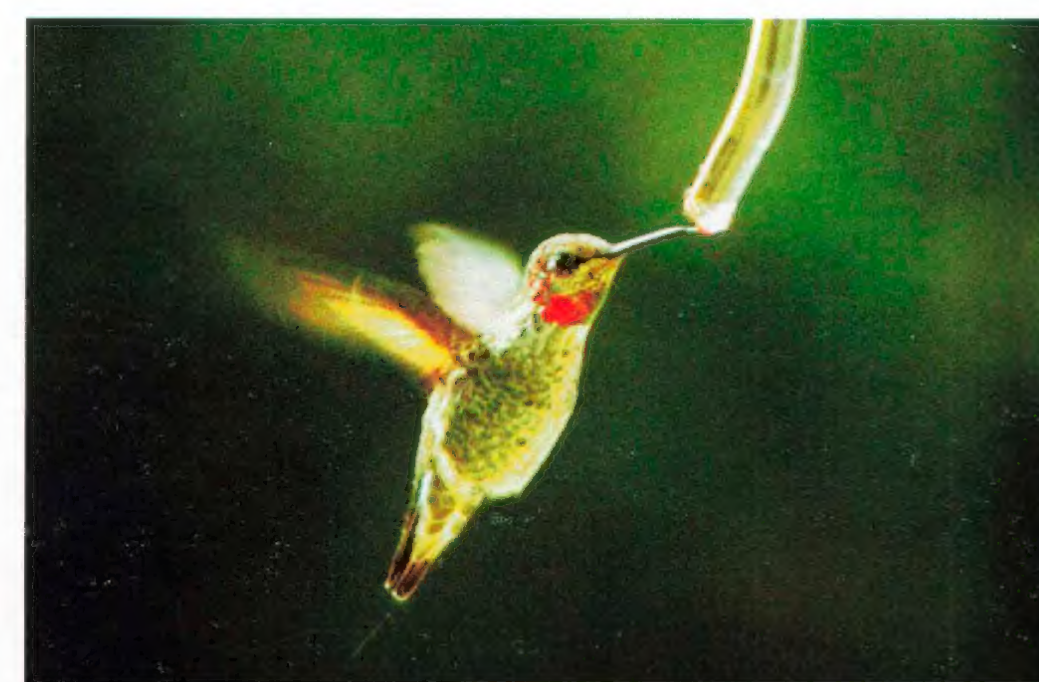
Calypte anna is the only hummingbird that lives in the Bay Area all year round. It ranges along the West Coast from Washington State to the northwest tip of Mexico. In the summer, it can also be found in the eastern parts of California.

Academy Specimens

The Academy's ornithology collection contains 305 specimens of this species, all from California, ranging from Humboldt County in the north to San Diego County in the south. The oldest specimen was collected in Hayward in 1881. The Academy also has 31 eggs and nests from the species, with the oldest collected in 1880.

Physical Characteristics

The male has a metallic green back and iridescent red forehead and throat. The female has a green back and head, and a grayish-white throat. It has a wing-span of five inches and weighs less than a quarter of an ounce (about the same weight as a nickel).



Diet

Anna's Hummingbirds feed on nectar, sap, and small insects. Interestingly, the last meals of some of the Academy's specimens are recorded in the notes that accompany them, such as "Crop full of honey" or "Crop full of black gnats." (The crop is part of a bird's digestive system.)



Raising the Reef

More than 20,000 pounds of sand have been hauled into place. Mangroves grown in Florida have been transported to San Francisco in climate-controlled trucks. The painstaking process of planting 2,000 colonies of coral has begun. And as biologists introduce sharks, rays, and a green sea turtle to their new home, the Academy's Philippine Coral Reef exhibit is officially coming to life.



Academy biologist Bart Shepherd introduces a young blacktip reef shark to its new home.



Diego, a captive-bred green sea turtle, explores his spacious new quarters in the mangrove lagoon.



Seth Wolters and Dave Chan use soft plastic bags to carry rays to their transport tank on moving day.

Over the next few months, Academy biologists will move thousands of live animals into their new homes in Golden Gate Park. While many have yet to be moved, some of the most popular aquarium residents are already enjoying their spacious new digs. The African penguins are now happily swimming at the end of African Hall, and the first rockfish are surfing the waves in the California Coast tank. The inhabitants of the Philippine Coral Reef are sure to join the list of favorites once the new Academy opens on September 27. Blacktip reef sharks, cownose rays, a honeycomb ray, and a green sea turtle were introduced to the exhibit's sandy-bottomed mangrove lagoon in April, and all are now cruising comfortably in the new space.

Mangrove lagoons are an integral part of tropical coral reef ecosystems, providing protection for young reef fish and preventing sedimentation that would kill nearby corals. The Academy's Philip-

pine Coral Reef exhibit contains both a mangrove lagoon and a living coral reef, allowing visitors to learn about the ways in which these two habitats depend on one another.

The view will be one rarely seen, even in the wild: a wooden boardwalk embedded with circular glass windows will allow visitors to walk out over the lagoon, where sharks, rays, and turtles will pass just inches beneath their feet. From there, guests will walk along the top of the living coral tank—and peer down into the deepest living coral display in the world.

In the wild, intricate coral reef ecosystems are built over thousands of years. In Golden Gate Park, however, Academy biologists must assemble a 212,000-gallon living reef in a matter of months. Their preparations for this unprecedented process began nearly three years ago, when a team of biologists and engineers transformed an exhibit hall at the Academy's temporary facility on Howard Street into a coral

nursery. By adding pipes, pumps, and filters to large plastic grape bins from Napa, they quickly built dozens of creative holding tanks. Then, using coral fragments from other zoos and aquariums around the country, they began filling these bins with “starter colonies” of coral—individual rocks planted with finger-sized fragments of coral cut from larger colonies.

After growing these colonies for several years, Academy biologists began planting them in the new Philippine Coral Reef tank in January, suiting up in SCUBA gear and placing each colony in a pre-determined location based on its light requirements. Through a series of weekly dives, they will eventually populate the tank with nearly 2,000 colonies of living coral. About 4,000 colorful reef fish will keep the corals company, along with anemones, snails, and giant clams. By opening day, the coral reef and mangrove lagoon will be teeming with life, providing a glimpse into the spectacular biodiversity of the Philippines.

Patagonia from a Scientist-Explorer's Perspective

Academy Senior Curator Dr. Terry Gosliner has seen the world many times over through the eyes of a scientist. Studying nudibranchs—also known as sea slugs—he's traveled to southern Africa and the western Indian Ocean, to Papua New Guinea and the Galápagos. But when Gosliner talks about Chilean Patagonia, at the southernmost tip of South America, he speaks with the passion of an explorer.

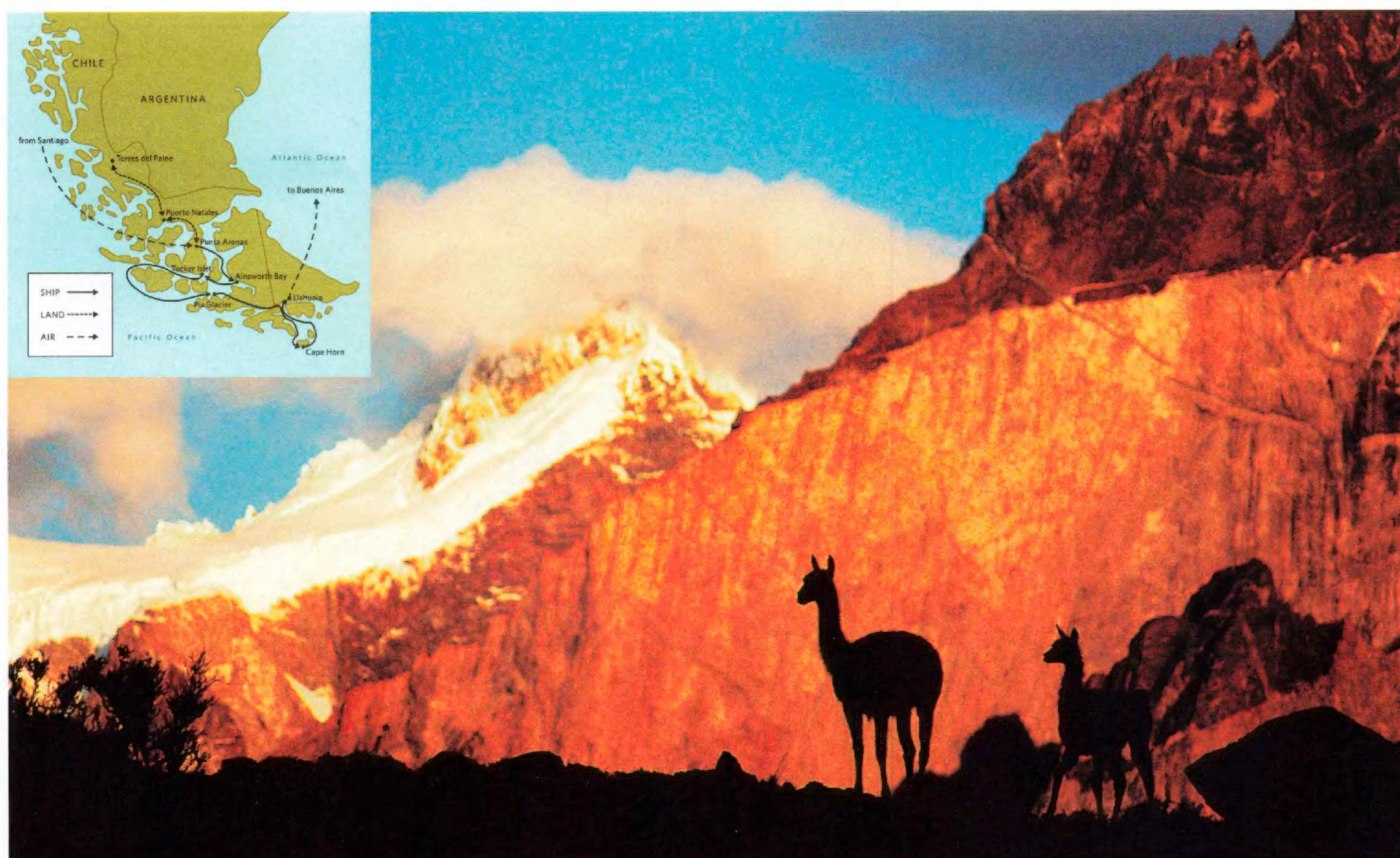
"To see the rugged mountains of Torres del Paine National Forest...to stand on the last outpost before you get to Antarctica...to feel the spirit of Darwin in the Beagle Channel...to know you're at the end of the world—it's the ultimate adventure," says Gosliner. And in October, he will share it with Academy members when he and his wife Bonnie (a librarian by profession and naturalist by marriage) lead the Academy voyage *Patagonia: Crown Jewel of South America*, aboard the elegant ship *Via Australis*.

Gosliner is a self-described "science nerd" who knows what it means to get hooked on the natural world through the Academy. A fourth-generation Californian and a native San Franciscan,

he visited the Academy frequently as a child, and it was an Academy scientist who encouraged him to publish his first paper on nudibranchs, while he was still in high school. He's also a veteran of Academy trips, having led more than a dozen adventures.

In Patagonia, Gosliner will introduce Academy members to wonders well beyond his familiar ocean domain. The journey begins in cosmopolitan Buenos Aires and continues through breathtaking landscapes of lush forest, volcanoes, fjords, ice flows, and primeval plants. Wildlife abounds, from majestic condors and llama-like guanacos to gray foxes and Magellanic penguins. And if natural wonders, experienced in the moment, aren't enough, there's a rich past to relish; centuries of explorers, including Charles Darwin aboard the *HMS Beagle*, have braved passage around legendary Cape Horn in search of adventure and discovery.

These and other wonders make Patagonia the ultimate destination for exploring biodiversity, the history of life on Earth, and the conservation issues that will shape the future of our home planet. "It reminds me that we still have so much to learn," says Gosliner.



Expedition Highlights

- See ancient glaciers now threatened by climate change
- Sit by a picture window in Explora Lodge, sipping local wines and enjoying a view of granite spires and waterfalls
- Explore the spectacular glacial lakes of Torres del Paine on foot or horseback
- Meet Magellanic penguins on their home turf
- Sail Drake Passage from the Pacific to the Atlantic
- Inhale the fragrance of cazuela, a regional soup, in a charming café in Santiago while toasting an unforgettable trip with a glass of merlot from the Rapel Valley

Trip Details

Destination: Patagonia, the Crown Jewel of South America

Dates: November 4-17, 2008

Vessel: Aboard the *Via Australis*

Guides: Bonnie and Dr. Terry Gosliner

Cost: From \$7,990/person (based on double occupancy plus airfare)

Upcoming Academy Adventures

Polar Bears and Wildlife of Churchill
November 4-10, 2008

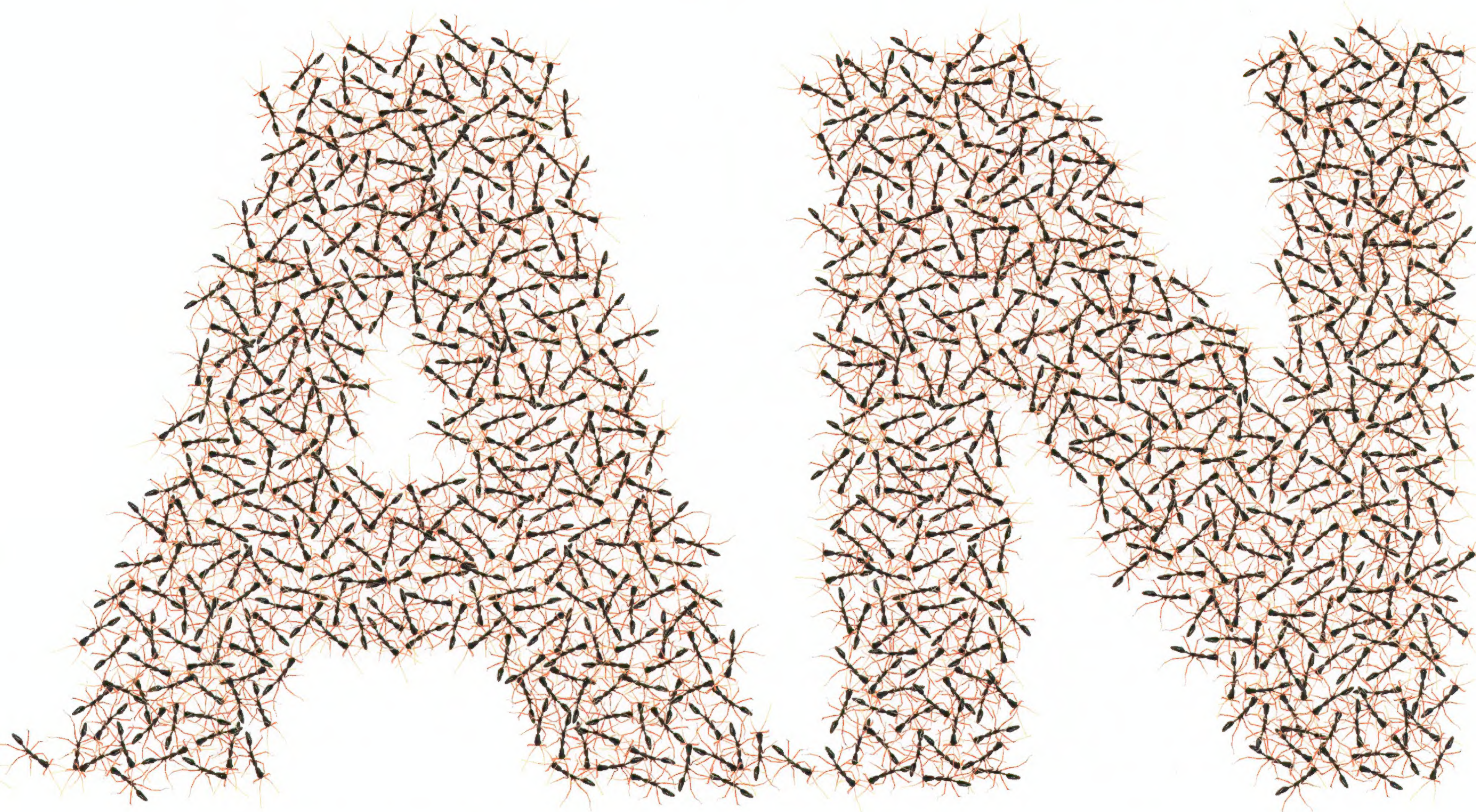
Galápagos in the Year of Darwin: Celebrating Darwin's 200th Birthday
February 9-18, 2009

Baja: Among the Great Whales Aboard the *National Geographic Sea Bird*
February 14-21, 2009

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Most people see ants as pesky kitchen intruders that should be eliminated from countertops worldwide.

Academy entomologist Brian Fisher looks at ants and sees a way to save the planet. He has spent the past



Dr. Brian Fisher is a man with ant-like determination. When he first set out to document the diversity of ants in Madagascar, he could never have anticipated the many obstacles he would face. Flash floods would wash out roads and bridges. Leeches would crawl up his nose. He would have to become an expert at repairing Toyota Land Cruisers. But like his industrious study subjects, he would persevere. Since his first trip to Madagascar in 1992, Fisher has discovered more than 800 new species of ants and traversed nearly as many miles on foot. Along the way, he has developed new

collecting techniques and taxonomic tools that have allowed him—both literally and figuratively—to put the ants of Madagascar on the map.

While its ant diversity is certainly impressive, Madagascar has historically been better known for its larger animals, including charismatic creatures like lemurs and chameleons. Because it has been isolated from other land masses for over 120 million years, the country contains an extremely high number of plants and animals that cannot be found anywhere else on Earth. Scientific surveys have revealed that nearly 13,000 species of plants and vertebrate animals are found exclusively on Madagascar,

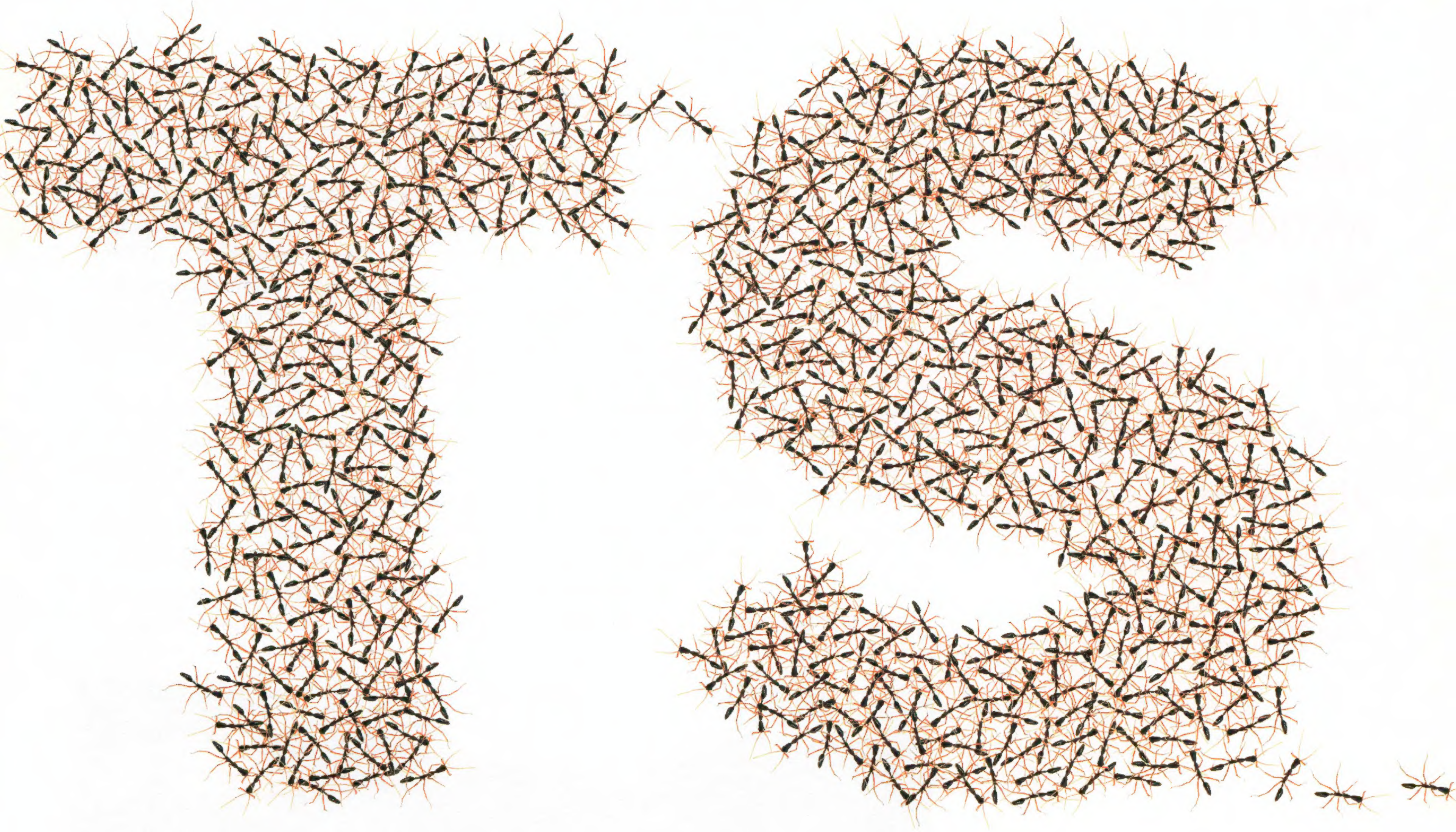
MADAGASCAR



Location

About 200 miles off the coast of eastern Africa

16 years attempting to catalogue every species of ant in Madagascar. Now, he is using that data to help the country create a conservation map that will protect the maximum number of species.



Size

587,040 square kilometers (about the size of Oregon and California)

Hotspot

Recognized as one of 34 biodiversity hotspots on the planet

including over 90 percent of the island's reptiles, amphibians, and mammals.

So why pay attention to the ants? For one thing, ants can't readily cross rivers, mountains, and other barriers, so they stay localized and become specialists in relatively small home ranges. This makes them a useful tool for detecting ecological subtleties that might not be evident from looking only at larger animals. According to Fisher, if a forest has a varied ant population, it most likely has a unique history and contains a unique assemblage of other species as well. Additionally, ants fulfill a critical role in their ecosystems, recycling nutrients and other biological material. "Although

you'd never want to do it, you could remove all the birds and still have a forest," says Fisher. "But you can't have a forest without invertebrates. It won't function anymore. The ants are the glue that holds it all together."

In 2003, the Malagasy government announced that it planned to triple the country's protected-area network by the end of 2008. Through this remarkable initiative, they committed to protect a total of 15 million acres, or about 10% of the island's total land. At the time, only 5 million acres of land had been designated. Fisher saw an opportunity to help them make the most of the remaining 10 million acres. He began to talk to

"Although you'd never want to do it, you could remove all the birds and still have a forest. But you can't have a forest without invertebrates. It won't function anymore. The ants are the glue that holds it all together."

—BRIAN FISHER

colleagues in Madagascar about a new type of conservation roadmap—one that took into account not only the country's mammals, reptiles, and other bony creatures, but also its insects.

This past April, Fisher and his collaborators published a groundbreaking new study in the journal *Science*. Using distribution data from 2,315 species of ants, butterflies, frogs, geckos, lemurs, and plants found only in Madagascar, the team proposed specific locations for new protected areas to complete the country's reserve network. By running a complex algorithm that took into account distribution data from six different animal and plant groups, they were able to recommend protected areas that would preserve all 2,315 species in their study. The researchers were also able to demonstrate the pitfalls of making conservation decisions based on a single set of animals—their data indicated that choosing conservation areas based on a single taxon would result in a reserve network that failed to protect between 16 to 39 percent of the species in their study.

This type of complex analysis has not been possible in the past because of a lack of data on species distributions

as well as computational constraints on achieving high-resolution assessments over large geographic areas. To address the first issue, Fisher had to find a faster way to identify and describe new species of ants—a process that is complicated by the fact that workers, soldiers, queens and males often look vastly different from one another even if they belong to the same species. Traditional methods would require him to spend hundreds of hours hunched over a microscope, and with an impending 2008 deadline, he didn't have that kind of time. Instead, he turned to a tool called DNA barcoding, a process that allows scientists to distinguish between species based on the genetic makeup of a small stretch of DNA. Although the system cannot completely replace traditional methods, Fisher found that it was able to quickly and accurately group ants into defined species.

To overcome the second obstacle, Fisher and his colleagues worked with computer scientists at AT&T and Finland's Helsinki University to develop the necessary software to run their analysis. Then, before running their final analysis, they placed additional weight on species with the highest risk of extinction—those with



Fisher and his team collected a new species of *Technomyrex* ant while traversing the Andohariana plateau, a high-elevation prairie surrounded by granite outcrops of ancient Precambrian rock.



Division of labor is one of the hallmarks of the complex social world of the ant. Here, a worker ant—a new species from the genus *Monomorium*—cares for the brood.

narrow ranges and those that have experienced a substantial loss of habitat. Their proposed solution not only affords protection to all of the species in their study; it also creates additional coverage for the most vulnerable species on their list.

The team's results provide some fresh insights into conservation decisions in Madagascar. For instance, they found that many endemic species currently lack protection because they live in areas with relatively low forest cover. Without the benefit of robust data analysis, these areas have historically been neglected in favor of protecting large forest blocks.

Although conservation areas in Madagascar must be identified by the end of 2008, final refinement and legal designation will not be completed until 2012. Therefore, Fisher and his colleagues will be able to refine their recommendations as new species are discovered, or as proposed protected areas are rejected or destroyed. This quantitative, practical approach to conservation decision-making is a valuable model for biodiversity hotspots in other parts of the world.

In an era of climate change, pollution, and rapid habitat loss, it's all too easy for doom and gloom to prevail when discuss-

ing conservation issues. However, Fisher is proving that—if armed with the right information—it is still possible to create conservation success stories. He is also working to ensure that the next generation of scientists will carry on his legacy in Madagascar. In November of 2006, he helped to open the Academy's new Madagascar Biodiversity Center in the country's capital city of Antananarivo. The center houses the island's National Entomology Collection, including thousands of ants collected by Fisher and his Malagasy students. There are *Camponotus* ants that tend other insects like sheep, harvesting the honeydew produced by their herd. There are *Nesomyrmex* ants that live exclusively inside the hollowed-out stems of flowering plants. There are even Dracula ants that feed on the blood of their own young.

Each ant has a story to tell. And Fisher tells them with such boundless enthusiasm that it's easy to see why many of his students have gone on to pursue higher degrees in entomology. The future guardians of their country's spectacular biodiversity, these students have officially joined the ranks of the converted—those who see ants as a national treasure. Fisher is recruiting new members every day.

Q&A with Brian Fisher



Q: When did you collect your first ant?

A: I collected my first ants in 1986 on Barro Colorado Island, Panama. I was there to study plants, but during the year on the island, I dropped the "pl" and concentrated just on the "ants."

Q: Do you have a favorite ant?


A: My favorite ants seem to always be the rarest, the least known, the ones that take me deepest in to the mountains or remote areas to collect; the ones few have ever seen alive. Despite my 16 years in Madagascar, there are a few ant genera I have only collected a couple of times. One species is a giant Dracula ant found only on a volcano in the north. It was collected once in 2000, but despite numerous trips to find a colony, they have never been seen again.

Q: Are ants ever dangerous?

A: A few bad ants give all ants a bad name. Of course it is no fun to run into ants in the kitchen or bathroom, but very few ants can hurt you, and none can transmit disease. Ants evolved from wasps, and like wasps many ants have a sting. The carpenter ants (*Camponotus*) and wood ants (*Formica*) do not have a sting but instead use chemical warfare. They will bite you and then spray formic acid into the wound.

Q: What do you plan to do next?

A: My next task is to train more students in Madagascar to help describe the 800 new species of ants we have discovered there. I am also raising funds to build the first field station on the island.



The countdown to opening day is well underway. The roof that started as a simple line drawing is now a blossoming reality. Underneath that roof, a rainforest is growing, a coral reef is teeming with life, scientists are conducting research, and a pendulum is about to start swinging. New exhibits are under construction, a new planetarium show is being produced, and new animals are being introduced to displays each week.

The Great Migration back to Golden Gate Park is nearing completion, and a new chapter awaits.

A photograph of a modern building's exterior. The building features a large glass facade and a prominent blue structural frame. The roof is composed of a series of parallel glass panels supported by a metal grid. The text "Coming Soon..." is overlaid in a white, sans-serif font across the center of the image. The scene is brightly lit, suggesting a sunny day, with shadows cast on the ground.

Coming Soon...



Doors open S



September 27

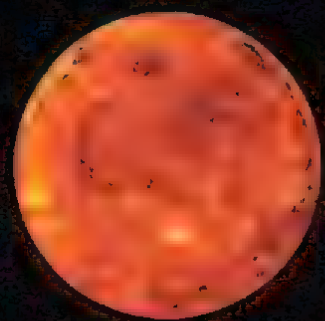
skyguide



Mercury

36 million miles
from the Sun

At the beginning of July, Mercury is briefly visible in the predawn sky. By mid-month, it descends back into the Sun's glow. Hidden from view until mid-August, it reappears in the evening sky, taking part in a rare display of all five naked-eye planets at the same time: 30 minutes after sunset, look very low in the west-northwest for Mercury, Venus, and (at 1/100 the brightness of Venus) Saturn. Mars is slightly higher in the west and much easier to see, and Jupiter is low in the south-southeast.



Venus

67.2 million miles
from the Sun

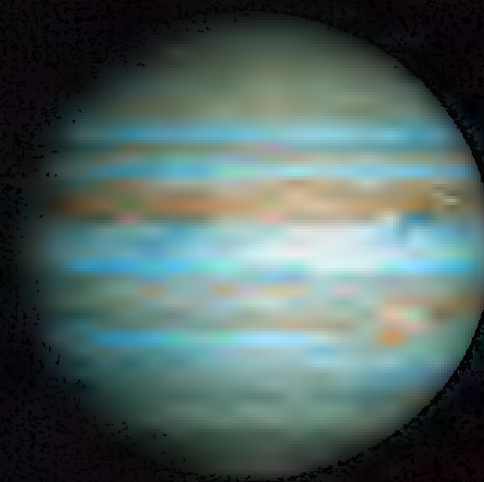
Venus is only beginning to emerge from the Sun's glow in early July, lingering quite low and not becoming visible until perhaps mid-August, when it clusters tightly with Saturn and Mercury. At this time, you might be lucky enough to see not only these three difficult planets, but also Mars and Jupiter at the same time. The Moon is nearby on August 2 (its pass in July is too near the Sun's glow to be seen).



Mars

141.6 million miles
from the Sun

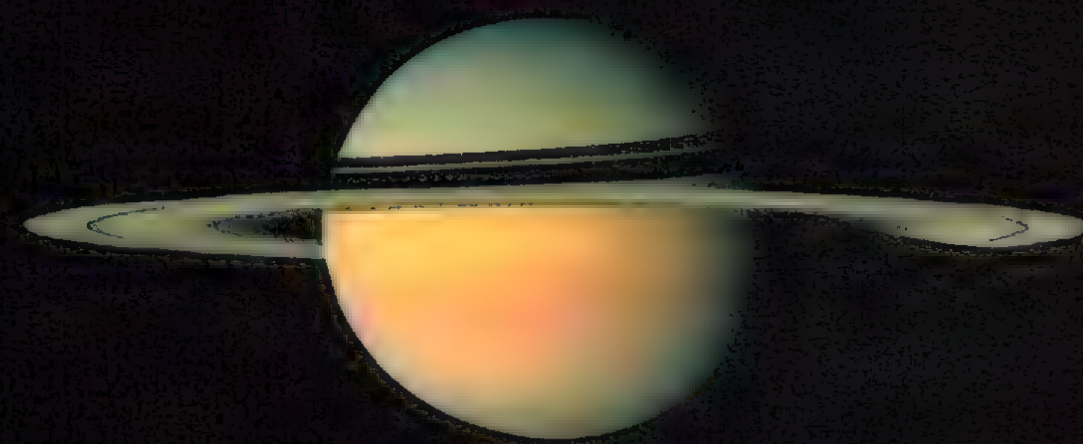
The Red Planet is located near Saturn, low in the west just after sunset as July opens. The two are closest together on July 10, and Mars eventually sinks slowly into the setting Sun's glow by the end of August, clustering very prettily with Venus and Mercury. The Moon appears nearby on the evenings of July 5 and 6 (with Saturn and the star Regulus both nearby) and August 3.



Jupiter

483.6 million miles
from the Sun

The second-brightest planet reaches opposition on July 9, rising at sunset and visible all night long against the stars of Sagittarius the Archer. Carefully note its location against the stars from week to week, and you may notice it slowly "retrograding"—or moving from east to west against the stars. The Moon passes nearby on July 16 and August 12.



Saturn

886.7 million miles
from the Sun

Already descending in the west at sunset in July, the "Ringed Planet" hovers in Leo, not far from the bright star Regulus. Watch as reddish Mars catches up to them, passing less than a degree from Saturn on July 10. Not to be outdone, brilliant Venus passes Saturn on August 13 in the closest planetary encounter of the year, though quite close to the Sun's bright glow (at that time, Venus will be 100 times brighter than Saturn). By late August, Saturn disappears from view into the Sun's

glare. The Moon pairs with Saturn on the evening of July 6, with Mars also nearby, and on August 2, with Venus joining in but hard to see in the setting Sun.



To the Moon!

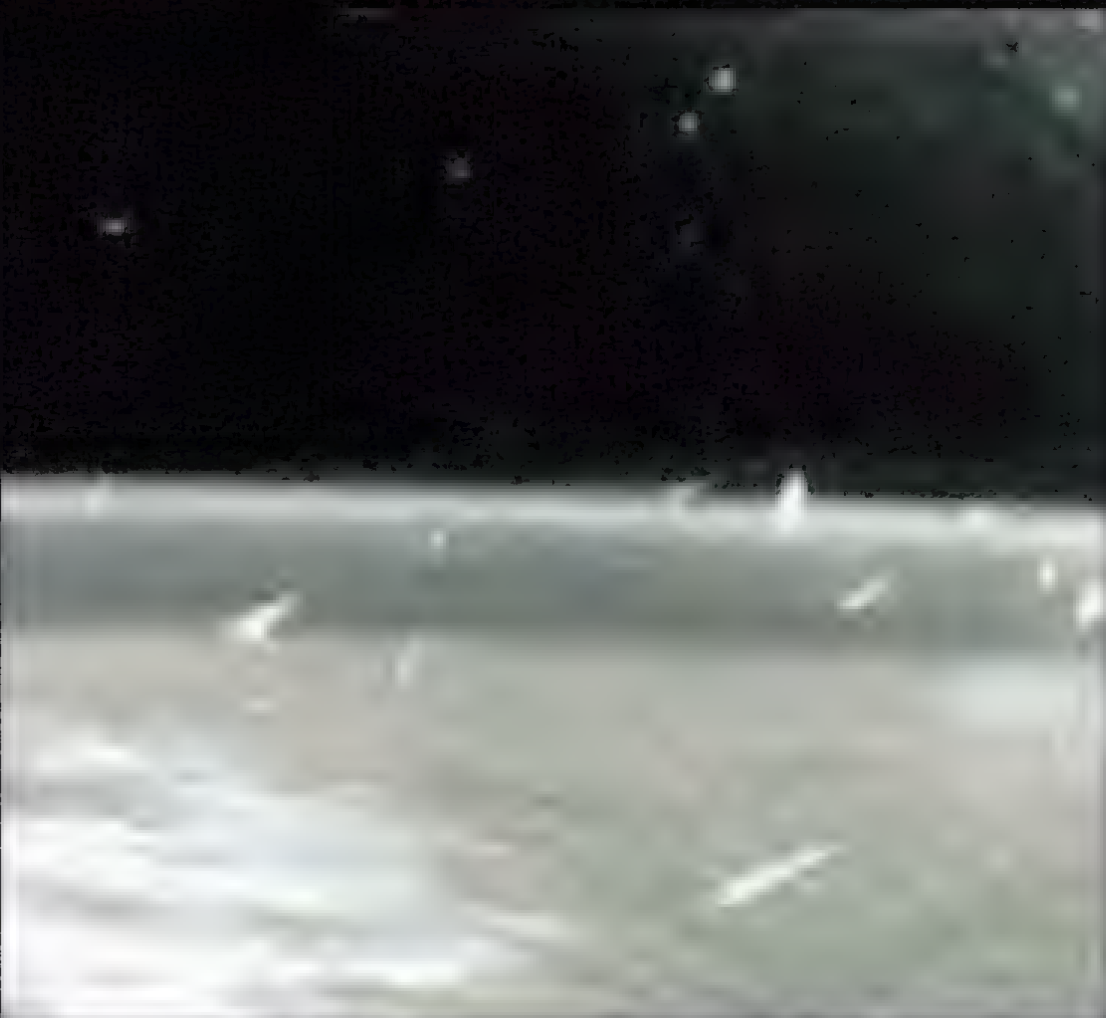
This year marks the 39th anniversary of the Apollo 11 landing on the Moon, which occurred on July 20, 1969.



Fireworks? I'll show you fireworks...

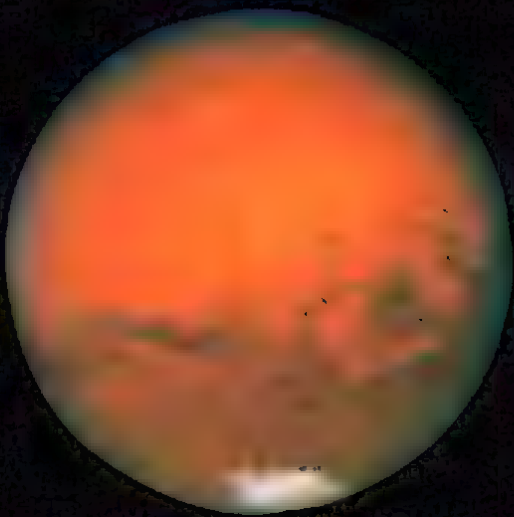
The stellar explosion that created the famous Crab Nebula in Taurus was recorded on July 4, 1054 AD by Chinese astronomers, using naked-eye observations. It was seen in the daytime for three weeks, dimming gradually and remaining visible in the nighttime sky for nearly two years. It is also believed to have been seen by Native American skywatchers in Arizona and New Mexico, who left rock drawings of the event in Navajo Canyon, White Mesa, and Chaco Canyon.

Meteor Showers



The image shows an unusual view of a meteor shower...from above, as seen by an orbiting satellite over a period of 48 minutes.

Every summer, we hear about the Perseid meteors, which are seen when Earth passes through the dust trail left behind by an old comet, creating a fiery rain of burning dust particles in the atmosphere. Is that the only meteor shower of the year? Not at all, but it's the most famous in the Northern Hemisphere because it's one of the most intense, and it happens when the weather is typically pleasant enough to allow skywatching late into the night and even into predawn hours. Rivaling the August Perseids are the lesser-known Geminid meteors of December, which are just as intense, with about 50 or 60 meteors per hour, and which many astronomers say are actually more reliable than the Perseids. There are several meteor showers each month, but they tend to be only a fraction as intense as the Perseids or Geminids, and some are detectable only by their effects on radio transmissions.



The Mars Hoax
False e-mail rumors are still in circulation stating that in August, Mars will be closer and brighter than it's been for thousands of years. However, that close approach occurred in 2003, and it won't happen again until 2287.

Skywatcher's Guide (July - August 2008)

July 2
New Moon at 7:19 pm PDT. The Moon still plays an important role in the calendars of some cultures—for example, naked-eye sighting of the first visible crescent after new Moon marks the start of each month in the Islamic calendar. Muslims around the world will have to wait until tomorrow's sunset, then, to begin the month Rajab.

July 4
Earth at aphelion, or farthest from the Sun, at 94.5 million miles. This is about 3.1 million miles farther than when it's at its closest point, or perihelion, which occurs on January 3. Notice that summer for the Northern Hemisphere occurs when Earth is farthest from its star, showing that the seasons have nothing to do with our distance from the Sun.

July 18
Full Moon against the stars of Capricornus, also known as both the "Buck Moon" and the "Thunder Moon" to the Algonquin, the "Rain Moon" to the San Ildefonso, and the "Ripe Moon" to the San Juan.

July 27
Peak of the Delta Aquarid meteor shower, a display that's better-known in the Southern Hemisphere. Travelers south of the equator can expect about 20 medium-speed meteors per hour.

August 1
New Moon at 3:13 am PDT. Muslims start of the month Sha'ban with the sighting of the first visible crescent after new Moon, which most of the world will see tomorrow after sunset. This is

one of those rare occasions when the new Moon moves precisely between Earth and the Sun, casting its shadow onto parts of our planet. Skywatchers in Russia, Mongolia, and China are treated to a total solar eclipse. No part of this eclipse is directly visible from any part of the U.S.

August 12
Peak of the annual Perseid meteor shower, averaging about 60 meteors per hour. However, this year's peak coincides with a waxing gibbous Moon, whose bright light will wash fainter meteors from view.

August 16
Full Moon, also known to the Choctaw as the "Women's Moon," to the Cheyenne as the "Time When the Cherries are Ripe," and to Osage as the "Yellow Flower Moon." A partial lunar eclipse can be seen from South America, Europe, Africa, the Middle East, and Asia as the Moon moves partly through Earth's shadow, nearly 80% of its disk being covered in darkness. Only the end of the eclipse might be visible from the northeastern U.S., the Carolina coast, and the tip of southern Florida.

August 30
New Moon (the second this month) occurs too late in the day for a crescent to be seen at sunset. Tomorrow it'll be visible throughout much of the world (except, perhaps, the U.S.), low in the west just after sundown, and its sighting will mark the start of the month Ramadan in the Islamic calendar (U.S. skywatchers may have to wait another day to see the crescent).

	Sunrise	Local Noon	Sunset
July 1	5:52 am PDT	1:14 pm PDT	8:36 pm PDT
August 1	6:14 am PDT	1:16 pm PDT	8:18 pm PDT

Times are for San Francisco, CA, and will vary slightly for other locations.

Academy
scientist **Rich
Mooi** dives to
the bottom of
the ocean and
encounters a
primordial battle
of the deep.



Stalking Sea Urchins

The hunter is a gross caricature of a pincushion, about the size of a fist studded with a profusion of eight-inch spines. The hunted could be mistaken for a flower, standing nearly two feet tall and swaying in the gentle current. The hunter creeps endlessly over the terrain, relying not on sight (it has no eyes) but on touch. Guided by its spines, it searches for its next meal.

The hunted also has no eyes, but it can feel the spines of the hunter brushing up against it. It recognizes the danger and immediately swoons. Lying prone on the ground now, it uses its long “petals”—which are actually jointed arms—to pull itself away from the hunter. At the same time, it amputates itself by shedding the very end of its stalk. The hunter maneuvers itself over this discarded end and uses its five-part jaw to crunch it into pieces. Meanwhile, the rest of the hunted crawls away to live another day.

Is this another planet’s version of the African plains, or a fantasy sequence from Salvador Dali’s imagination? The answer is neither. This drama occurs in real life, every day as it has for millions of years. But most have never witnessed it because it is staged in one of the most

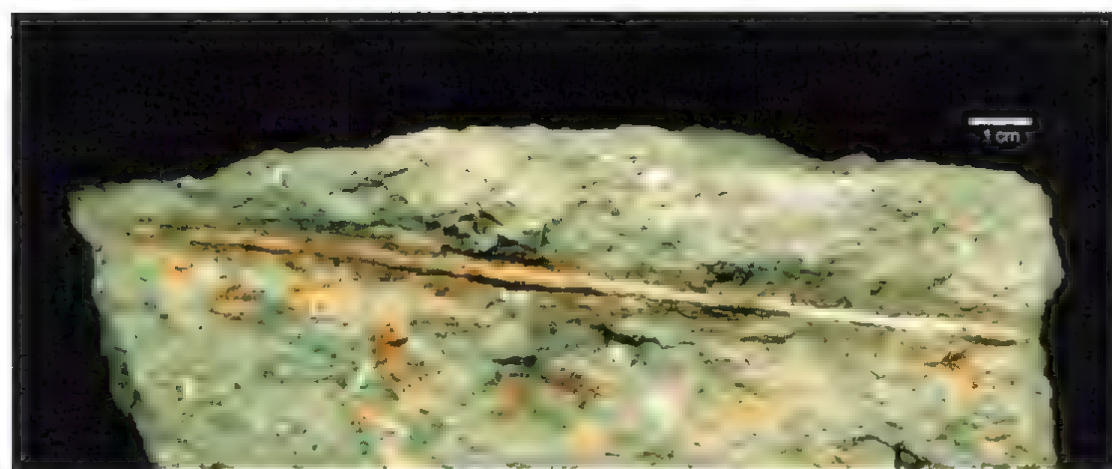
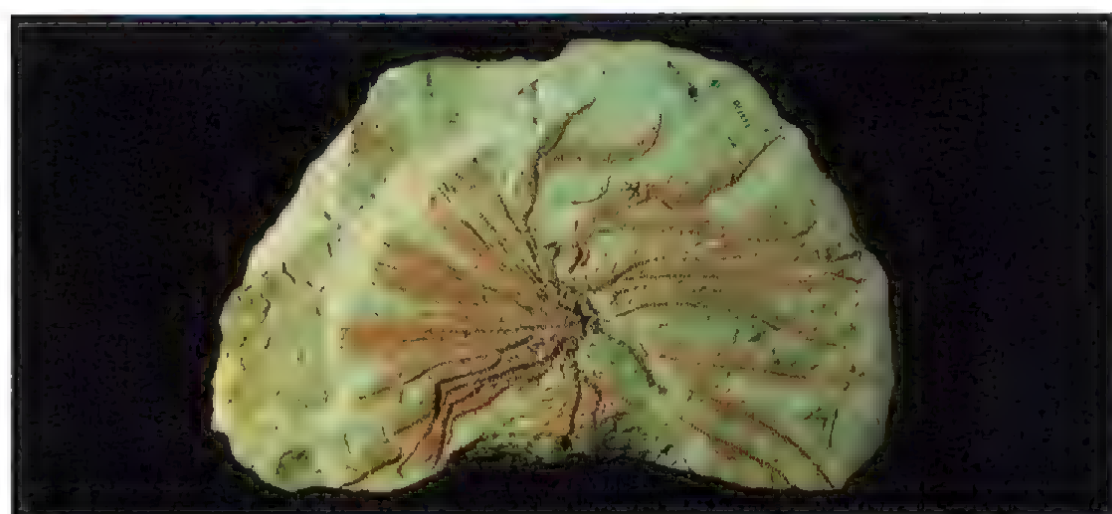
remote locations on Earth—the bottom of the ocean, under complete darkness and crushing pressure.

Dr. Rich Mooi, Curator of Invertebrate Zoology and Geology at the Academy, first encountered this battle of the deep during a research cruise to the Bahamas in 1998. The expedition leader was Charles Messing, an expert on sea lilies—an ancient group of animals that look like otherworldly flowers sprouting from the seafloor, related to sea stars and sea urchins. For years, Messing had studied the sea lilies that inhabit the waters around the Bahamas, descending in a submersible to 1500 feet to find his subjects. After locating a sea lily, he would bring it to the surface to fit a plastic ring around its stalk and then put it back on the seafloor to monitor its

movement. He realized that the sea lilies must be shedding the ends of their stalks, because when he revisited them later, some of the rings were either missing or located at a lower level on the stalk. The reason for this self-amputation, however, eluded him.

“To help solve the mystery,” says Mooi, “he invited a variety of different biologists on the cruise in 1998. He hoped there would be a synergy or spark among us. And that’s exactly what happened.”

One day, Mooi happened to be walking by while another scientist, Tomasz Baumiller, was watching video footage of sea lilies from a previous submersible dive. Mooi, who is an expert on sea urchins, immediately noticed a large urchin sitting among pieces of sea lilies in one frame. Although no one had ever



As the next step in his research, Mooi will examine the fossil record to determine how far back the urchin-lily interaction goes. Above are images of a fossil sea lily (top) and fossil urchin spine (bottom) from the Smithsonian Institution's collections (Paleobiology Department, National Museum of Natural History).

considered urchins to be major predators of sea lilies, Mooi's urchin-centric mind jumped on the possibility.

"To me, it looked like a lion in a cave with zebra bones scattered all around," says Mooi. "That was my first 'ah-ha!' moment during the expedition."

Mooi decided to test his hunch by collecting some sea urchins and examining their stomach contents. On his first dive in the submersible, he and a crew member squeezed into the "lockout chamber" at the back of the submersible, which was barely larger than a refrigerator. Luckily, Mooi is not claustrophobic, but, he says, "I did have to hope that the other person had taken a shower." The front of the submersible was an acrylic sphere, much more spacious by comparison, and it was occupied by the pilot and another scientist. Mooi would have to wait until his second dive to experience the roomier accommodations.

Although the Bahamas are typically warm and sunny, Mooi was wearing a sweater in preparation for the dive. As the submersible drifted down to 1500 feet, the water became increasingly dark and cold. They finally reached the bottom and began to coast along the seafloor. Mooi looked out his tiny eight-inch porthole and saw several species of urchins, sea lilies, snails, and fish pass silently by. When they found the same

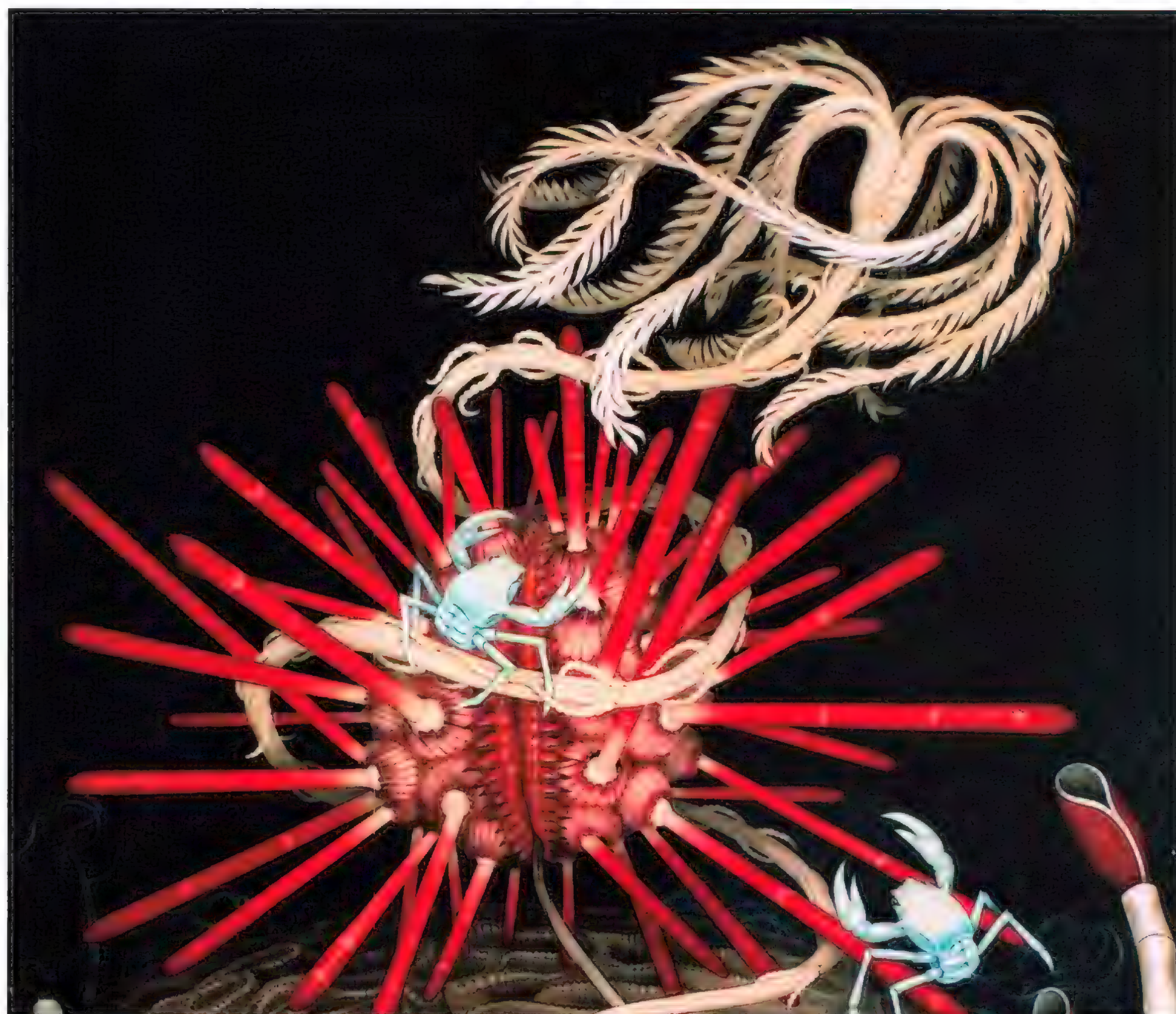
species of urchin that appeared in the video, the pilot used a mechanical claw to collect some specimens.

Back on the ship, Mooi dissected one of the urchins and found that a whopping 72% of its gut contents consisted of sea lily pieces.

"That was my confirming 'ah-ha!' moment," he says. "It was an amazing feeling—it qualifies as one of the top 'ah-ha!' moments in my 30-year career."

Messing's mysterious case of the self-amputating sea lilies suddenly made sense. An urchin creeps along the seafloor until it contacts a sea lily with its spines. The sea lily falls down, sheds the end of its stalk as a distraction, and crawls away—much like a lizard drops its tail to distract a predator. The urchin then consumes the stalk. Mooi doubts that it does this for nutrition, as the stalk has very little flesh in it, but rather to acquire calcium carbonate, which is scarce at those depths. Both urchins and sea lilies use calcium carbonate to make their skeletons.

"It was an amazing feeling—it qualifies as one of the top 'ah-ha!' moments in my 30-year career."



During her year-long collaboration with Rich Mooi as the Academy's Artist-in-Residence, Tiffany Bozic heard the story of the urchin and the lily and painted this creative interpretation, entitled "Battle of the Deep." 45" x 35", acrylic on maple panel.



Diving Deep

When you're diving in a submersible to a depth of 1500 feet, there are two main threats to your life. First is the pressure: due to the sheer weight of the water, the ambient pressure increases by one atmosphere for every 33 feet that you descend. Therefore, at 1500 feet, the pressure is approximately 680 pounds per square inch—enough to collapse your lungs or breach your sinuses. If a crack appears in the hull and the submersible floods, it's "adios" in a heartbeat.

The second danger is slower-acting but just as lethal: the cold. Far from the sunlit surface, the water at the bottom of the ocean hovers just above freezing. The air in the submersible creeps toward 1-2 degrees Celsius as it equilibrates with the ambient water temperature. If you're down in the abyss too long—or worse, if you become stranded—death by hypothermia would be your number one concern.

Despite these risks—and the unsettling conditions of total darkness, extremely cramped quarters, and lack of a bathroom—scientists continue to descend in submersibles every day to conduct research. Perhaps it's the pioneering spirit that drives them, trumping the discomfort and danger. After all, they are exploring the most mysterious, little-known place left on Earth.

"Diving in a sub is a cosmic experience," confirms Rich Mooi. "It's fulfilling a childhood dream. I would do it again in an instant."

"It's like a hunt on the African plains, except in slow motion," Mooi says. "Sea lilies have been clocked crawling at 30 millimeters per second, which is apparently fast enough to escape the even slower urchins."

Mooi was particularly excited by this discovery because it answered a number of longstanding questions: 1. What slow-moving predator could have driven the evolution of crawling behavior in sea lilies? (Urchins.) 2. Why do sea lilies shed their stalks? (To distract urchins.) 3. Why aren't there more pieces of decomposed sea lily stalks in the sediment? (A lot of pieces are in the stomachs of sea urchins.) 4. According to the fossil record, most sea lily groups went extinct 250 million years ago. Why were the only survivors the ones that had anatomical features predisposed to crawling? (Urchins had evolved that feasted on non-mobile sea lilies.)

In the years following that fateful cruise, Mooi and his colleagues pieced together enough evidence—from urchin dissections, video footage, photographs, submersible observations, and examinations of seafloor debris—to present their findings in the January 2008 issue of the journal *Paleobiology*.^{*} The story of the stalking urchins even inspired a painting. As part of the Academy's 2007 exhibit *From the Depths: Inspiring Science and Art*, Oakland-based artist Tiffany Bozic created a large-scale piece entitled "Battle of the Deep," expressing the life-and-death struggle between the two animals.

So what will Mooi's next "ah-ha!" moment be? He wants to look far into the past, and dissect fossil urchins to see if there are any sea lily parts inside. He suspects there will be. Long before lions and zebras evolved on the plains of Africa, the drama between hunter and hunted, the urchin and the lily, was playing itself out in the depths of the sea.

^{*} These findings were reported in Baumiller T.K., Mooi R., Messing C.G. 2008. Urchins in the meadow: paleobiological and evolutionary implications of cidaroid predation on crinoids. *Paleobiology* 34(1): 22-34.

Q & A



Insiders Tell the Best Stories

Members, docents, interns and other close friends of the Academy often nurture a lifelong love of science—and have fascinating stories to share about what sparks their passion. In this issue, meet Eastwood Associates Louise and Don Heyneman and Careers in Science Intern Johnson Young.

Don Heyneman, a professor at the University of California, San Francisco, and his wife, Louise, get up close and personal with the natural world.

Q. Don, you've spent almost half a century as a UC faculty member, first at UCLA, then at UCSF teaching parasitology to medical students and doing research. How did you first get interested in science?

Don: I'm a native San Franciscan, and I practically grew up at the Academy. Some of my earliest childhood recollections are of the African Hall dioramas and Steinhart Aquarium exhibits. Then, when I was pursuing Eagle Scout badges, I took bird and mammal skeletons from Ocean Beach and the Presidio and dried them on the fire escape outside my bedroom window. My patient mother withstood the rank odors wafting in, despite her keen sense of smell.

Q. Your college studies were interrupted by World War II. How did you keep your interest in science alive?

Don: I had been a skier in the 10th Mountain Division, and then was an infantry training officer in the Philippines, and took my discharge locally. With an Army colleague, I organized an 18-month biological collecting expedition in Mindanao. When I returned to the States, I completed undergraduate and graduate degrees that permitted those early Academy-stimulated interests to mature.

Q. Louise, you and Don have been intrepid travelers, exploring Africa, China, India, the Middle East, South America, and Southeast Asia. What makes a trip memorable?

Louise: I recommend bringing a sense of adventure and curiosity. In the 1970s, we had a fine trip with the Academy to observe Baja California's wintering grey whales. A wonderful leader and 14 curious passengers—perfect!

Q. How do you share your love of science and the natural world?

Don: It starts with our family. I've just returned from birding in Assam Province in northeast India with our ornithologist daughter and her glaciologist husband. And I'm now a docent trainee at the Academy, in hopes of offering young hearts and minds the same opportunities the Academy provided me.

Louise: We have so much to thank the Academy for that we've made a legacy gift, becoming members of the Eastwood Associates.

Don: That gift honors memories as well as the future. When I was in high school, I studied plant morphology and systematics with John Thomas Howell, Alice Eastwood's assistant curator of botany. Years later I could return the favor by solving a parasitic disease epidemic that had hit the giant snakes exhibited around the Academy's alligator swamp.

To learn more about the Eastwood Associates, call 415.379.5407 or visit www.calacademy.org/give.



**Johnson Young
Careers in Science Intern**

College sophomore Johnson Young has already jumpstarted a career in research, gaining hands-on science skills by conducting water quality tests and developing feeding regimens for the Academy's Philippine Coral Reef exhibit.

What excites me about the Academy

The new level of interactivity, and the unexpected adventures. There will be lots of nooks and crannies to explore in the new building. Keep your eyes open!

Don't miss...

The carts on the public floor. Each is dedicated to a different aspect of science—from parasites to endangered animals—and is hosted by a Careers in Science intern like me. We'll be showing specimens and explaining the science behind the exhibits.

First place I'll take my friends

The living roof, for the amazing view. And the Philippine Coral Reef, where they can see what I'm working on.

Be sure to bring...

An open mind. Sometimes people get intimidated by the idea of "science." They think it's hard to get your head around. But science isn't just for scientists. At the Academy, there's something for everyone.

The Academy's Platinum Circle donors support the Careers in Science intern program. For more information, call 415.379.5413.

On the Scene

It's countdown to opening day, and Academy community members are taking advantage of "first peek" privileges in the Park.

1 Academy Friends Rozell and Peter Overmire admire the newly-installed dioramas in African Hall.

2 Eastwood Associates and Friends members Diane and Lloyd Root take in what will be 2.5 acres of California native plants on the Academy's living roof.

3 Docent, Friend, and Eastwood Associate Mary Ann Aronson knows her tour guests will say "wow!" when they see the Academy's living rainforest for the first time.

4 Parting is such sssssssweet sssssorrow, so docents Bobby Daza and Leslie MacDonald invite visitors to wish the red tail boa safe travels as it returns to Golden Gate Park.

5 Bill Patterson and Greg Farrington visit at a Guild event. Who knew you could wear coat and tie to a rainforest?

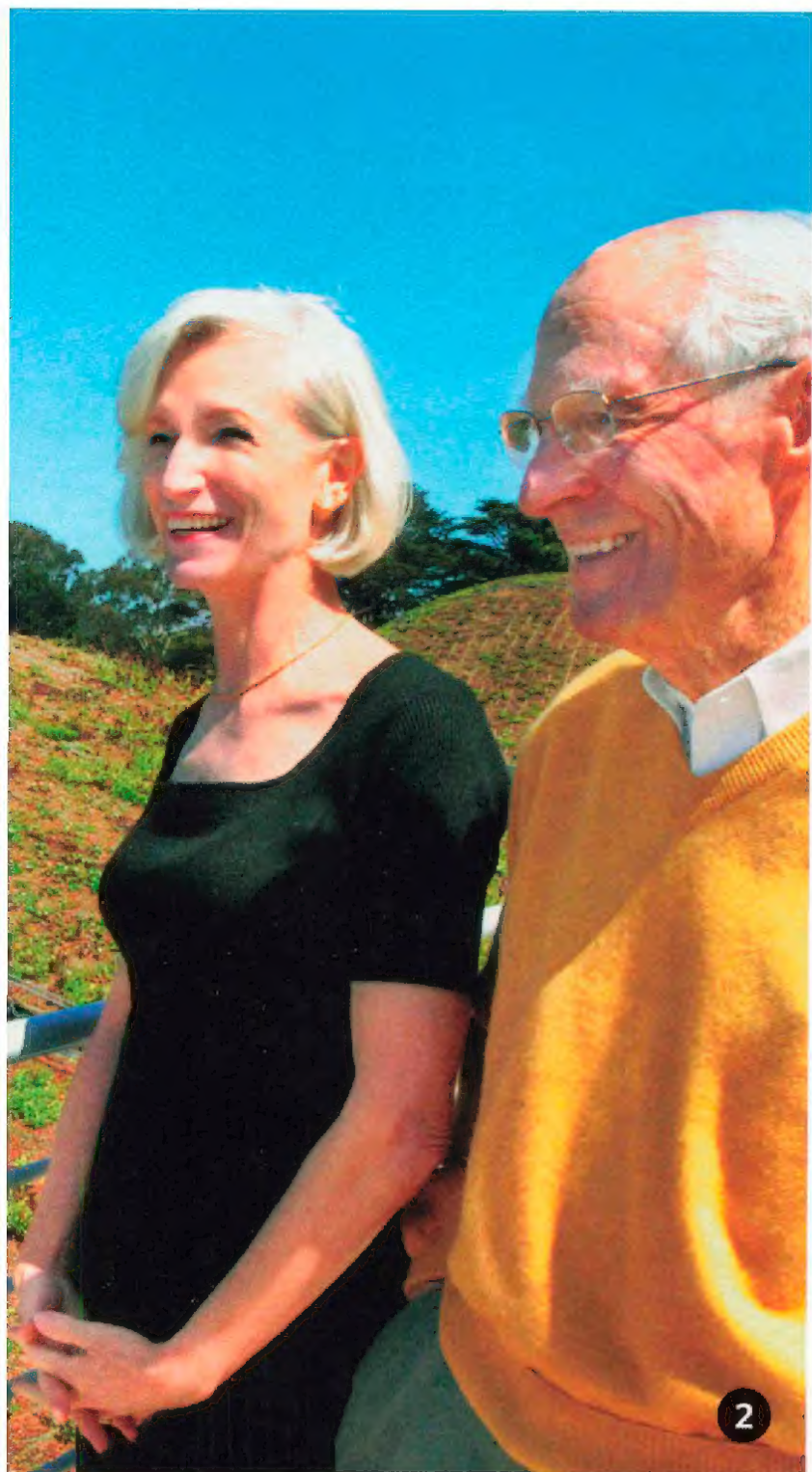
6 Docents, Friends, and Eastwood Associates Helen Heller and Mary Ann Aronson train to describe the rich life of the Academy's rainforest environments.

7 So long to the sea stars, but just for a few more months, as Howard Street closes.

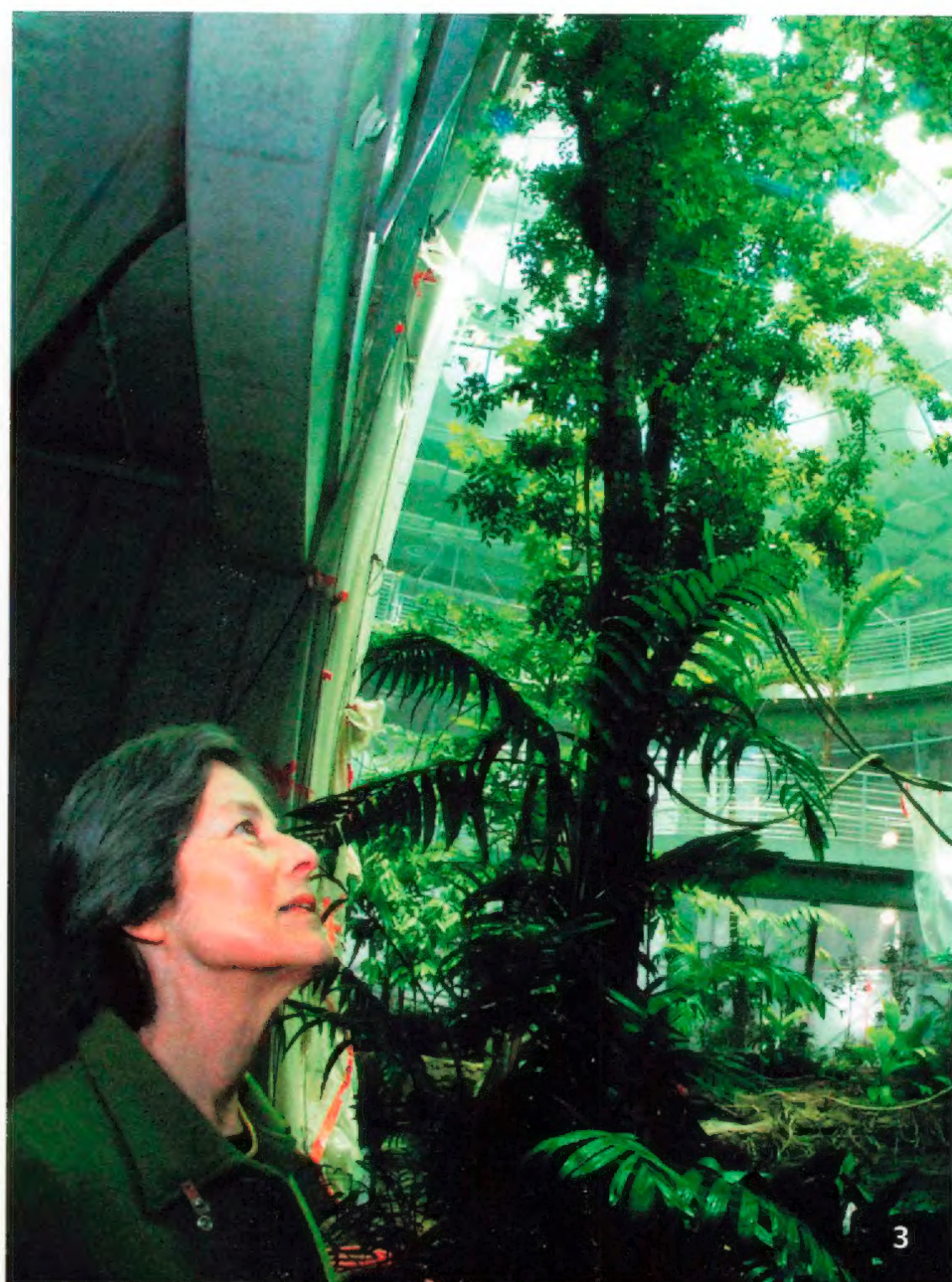
8 Bryn Brugioni joins Academy Guild and Friends members Jennifer Tobiason and Corrina Bonomo at a festive fashion event with eco-conscious designer Peter Som at Saks Fifth Avenue.

9 Guild members Molly and David Wadhwani, with a few underwater friends in the background, swim through 212,000 gallons of watery habitat.





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Get closer to science and the natural world, and be part of an exciting future by deepening your relationship with the Academy. Your increased support gives you a front-row seat as the new Academy prepares to open its doors.

Become a Friend and enjoy exciting new benefits, including an exclusive opening reception and private behind-the-scenes experiences. Learn more at www.calacademy.org/give/individual_giving.php.

The greenest Guild welcomes members with children who want to learn and experience more with their families, and get involved with science in fresh and exciting ways. Learn more at www.calacademy.org/join/guild.php.

Some things do last forever. For an enduring impact, join the Eastwood Associates and make the Academy part of your estate plan. Your legacy commitment to science, discovery, education, and a more sustainable world will shape the future. Learn more at www.calacademy.org/give/planned_giving.php.



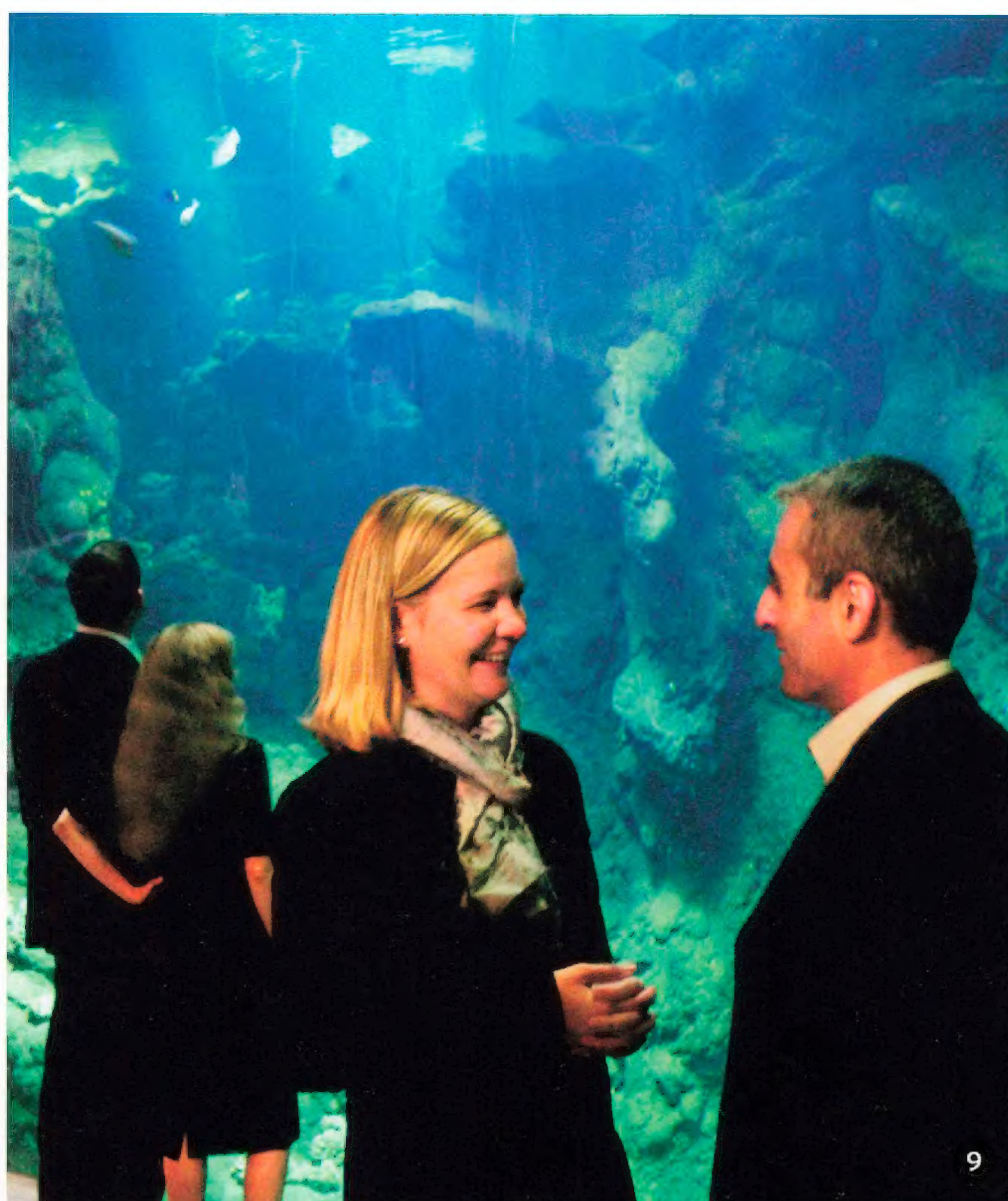
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In the spirit of cosmic new beginnings, help us kick off the new California Academy of Sciences with a bang-up celebration. The **Big Bang Opening Gala** happens Thursday, September 25, 2008, with a buffet dinner, music, and surprises. For more information or for tickets, call 415.379.5420.



8

Drew Altizer Photography



9

thank you!

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Academy Receives AT&T Foundation Grant

The Academy is honored to be one of only two organizations in California to receive an AT&T Foundation competitive grant that supports the integration of wireless technology into educational outreach programs. The \$25,000 grant will be used for cell phone audio stations in the new Academy, which will allow visitors to use their personal cell phones to learn more about an exhibit without renting special audio equipment. Nationwide, the AT&T Foundation awarded a total of \$1.5 million in grants to support 70 non-profit organizations with wireless applications and hardware.



Shaking off the Shivers

The oldest member of the Academy's colony of African penguins is now back in the swim of things, thanks to the warmth of a custom-made wetsuit. Pierre, who turned 25 in February, began suffering from a bout of baldness several years ago. Academy biologists tried every treatment in the books to prompt new feather growth, but none of the traditional strategies produced results. Finally, in an attempt to keep Pierre comfortable, senior aquatic biologist Pamela Schaller had an idea: why not fit the shivering bird with a neoprene wetsuit to keep him warm?

Schaller enlisted the help of Celeste Argel, an Early Childhood educator at the Academy with a special talent for sewing creative costumes.

Together, they designed a pattern and pieced together a prototype out of old sheets. After several fittings, they had perfected a pint-sized vest with adjustable Velcro seams that would accommodate weight fluctuations and leave Pierre's wings free for swimming. Schaller then delivered the prototype to Oceanic Worldwide, a California company that makes wetsuits for SCUBA divers. Several weeks later, just in time for Pierre's 25th birthday, Oceanic delivered the smallest wetsuit they had ever created.

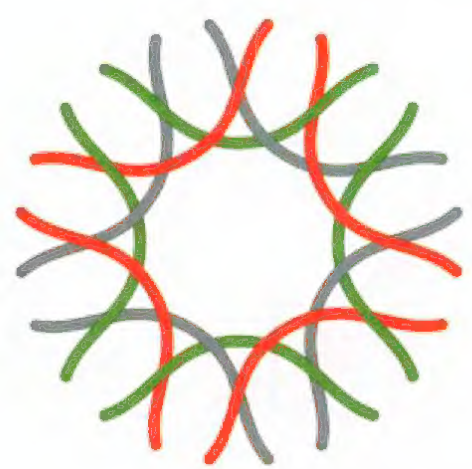
After wearing his wetsuit for just six weeks, something remarkable started to happen—Pierre's feathers began to grow back. Schaller suspects that because he was no longer using all of his energy to stay warm, Pierre was able

to divert calories to feather production once again. With a new lease on life, Pierre has now traded in his wetsuit for his traditional tuxedo and is once again swimming happily with the rest of the colony. Visitors to the new Academy will be able to check in on Pierre in his new home at the end of African Hall.



Warm Again

Since this photo was taken, Pierre has re-grown all of his feathers, and he no longer needs his wetsuit.



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